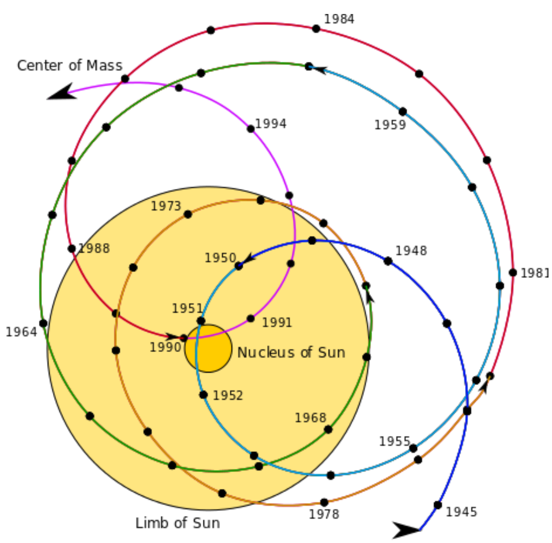
There is nothing at the other focus of a planet's ellipse.
The "empty" focus of the ellipse is just a mathematical construct. There doesn't need to be anything there for the planet to orbit in an ellipse.
> barycenter or centroid

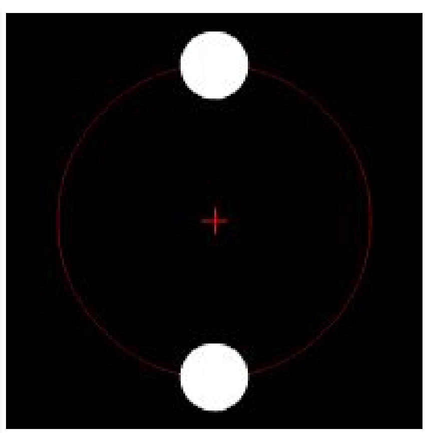
Every single object in the solar system exerts a gravitational pull on everything else.

The Earth, Sun and everything in the solar system orbits around/balances out at a specific point: the center of mass, or "barycenter." very close to the Sun itself, but not exactly at the Sun's center.

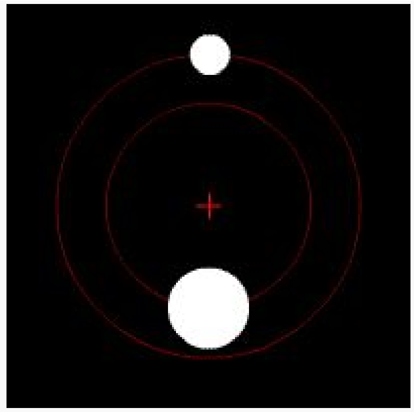
It's constantly changing depending upon where the planets are in their orbital paths.



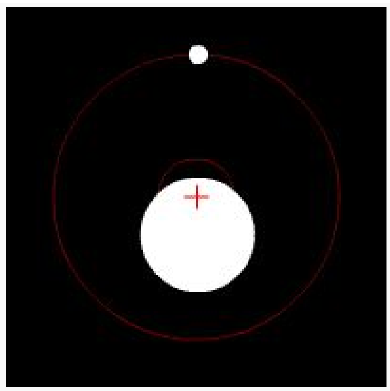
Images are representative (made by hand), not simulated.



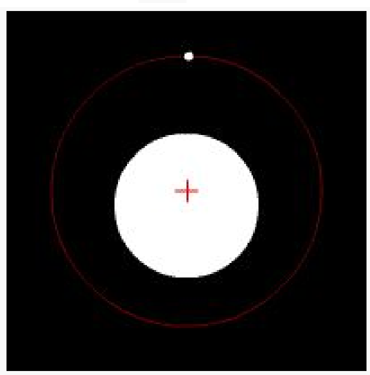
- Two bodies with the same mass orbiting a common barycenter (similar to the 90 Antiope system)

●


- Two bodies with a difference in mass orbiting a common barycenter external to both bodies, as in the Pluto–Charonsystem

●


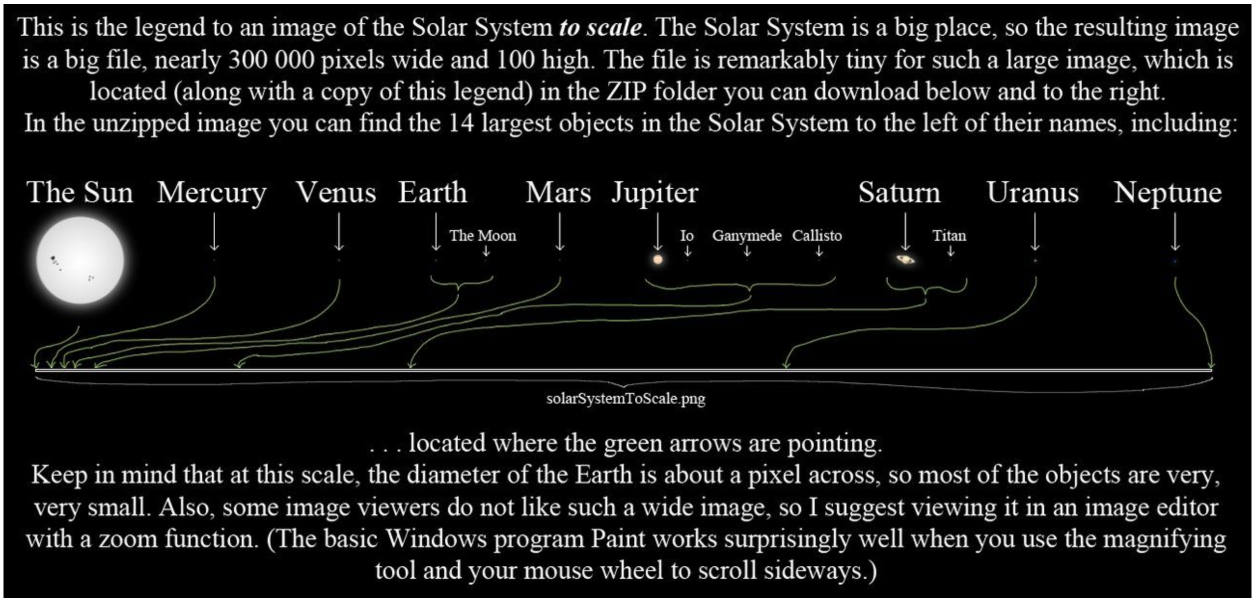
- Two bodies with a major difference in mass orbiting a common barycenter internal to one body (similar to the Earth–Moonsystem)

●


- Two bodies with an extreme difference in mass orbiting a common barycenter internal to one body (similar to the Sun–Earth system) the **Sun** - in fact, our whole solar system - **orbits** around the center of the Milky Way Galaxy

It is theoretically possible for a planet's orbit to be perfectly circular with the sun at the center, but this is never the case in reality.

(how close to circular the orbits of most planets are. The distance between the foci of the Earth's orbit is just under 5 million km. Compare this to the Sun's diameter of 1.4 million km.)



It helps to think about the extreme case when considering this question. Think of a comet that starts very far away from the sun and begins falling toward it due to gravity. The comet speeds up due to the acceleration from gravity. As it gets closer, the gravitational pull gets stronger and stronger. When it passes by close to the sun, the gravitational force is extremely strong (because the comet is so close to the sun) and the comet whips around the sun at very high speed in a tight arc, due to the huge force. It sort of gets "slingshot" around the sun and flung way back out into space. But now it is fighting the sun's gravity so it will go very far out and slow down, eventually stopping. Now since it has come almost to rest, it will fall back towards the sun again.

Clearly in this scenario, the orbit of the comet is extremely long and narrow, like a very stretched out ellipse. It is also clear that the sun is very close to one "end" of the ellipse, while there is nothing very close to the other "end" of the ellipse.

I hope this helps you understand the situation intuitively.

Is it the force of the comet then?

Noo

just the way it is with the inverse-square law for gravity---if the force law is inverse square, then the shape of the orbit must be a second-order equation, in other words, one of the conic sections: ellipse (which includes the circle as a special case), parabola, hyperbola. The ellipse is the only closed curve, so planets travel on ellipses. Comets from far out are on parabolas (actually a parabola is also a special case of an ellipse as well---it's an ellipse where the two focii are infinitely far apart). Other stars passing the sun are on hyperbolas (but only one branch of the hyperbola, not both!). The second-order nature of the equation makes it an ellipse. It's a sort of mathematical coincidence too that the Sun is at one focus.

The Babylonians were the first to realize that the Sun's motion along the ecliptic was not uniform, though they were unaware of why this was; it is today known that this is due to the Earth moving in an elliptic orbit around the Sun, with the Earth moving faster when it is nearer to the Sun at perihelion and moving slower when it is farther away at aphelion.[1]

In the 17th century, Johannes Kepler discovered that the orbits along which the planets travel around the Sun are ellipses with the Sun at one focus, and described this in his first law of planetary motion. Later, Isaac Newton explained this as a corollary of his law of universal gravitation.

Gravitation is the attraction of two objects with mass.
Newton's **law** states: The gravitational attraction force between two point masses is directly proportional to the product of their masses and **inversely** proportional to the **square** of their separation distance.

$$\frac{\text{Intensity}_1}{\text{Intensity}_2} = \frac{{\text{distance}_2}^2}{{\text{distance}_1}^2}$$

The density of flux lines is inversely proportional to the square of the distance from the source because the surface area of a sphere increases with the square of the radius. Thus the strength of the field is inversely proportional to the square of the distance from the source.

force, energy, or other conserved quantity is evenly radiated outward from a point source in three-dimensional space

Ellipse: flattened circle
it is a generalization of a circle, which is a special type of an ellipse having both focal points at the same location.

ellipsis
verb

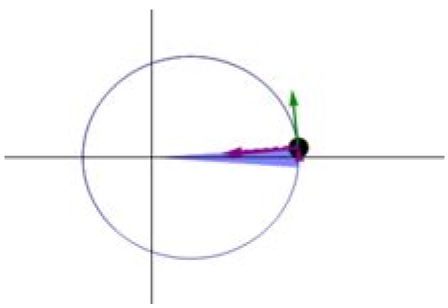
1. (*grammar*) To remove from a phrase a word which is grammatically needed, but which is clearly understood without having to be stated.

Elision
Elide
1585-95; < Latin *ēlīdere* to strike out, equivalent to *ē*-e-1+ *-līdere,* combining form of *laedere* to wound

ἔλλειψις (élleipsis, "omission" or “falling short”) **Apollonius of Perga** conics c. 262 BC – c. 190 BC

1753, from French ellipse (17c.), from Latin ellipsis "ellipse," also, "a falling short, deficit," from Greek elleipsis (see ellipsis). So called because the conic section of the cutting plane makes a smaller angle with the base than does the side of the cone, hence, a "falling short." First applied by Apollonius of Perga (3c. B.C.E.) to the curve which previously had been called the section of the acute-angled cone, but the word earlier had been technically applied to a rectangle one of whose sides coincides with a part of a given line (Euclid, VI. 27).

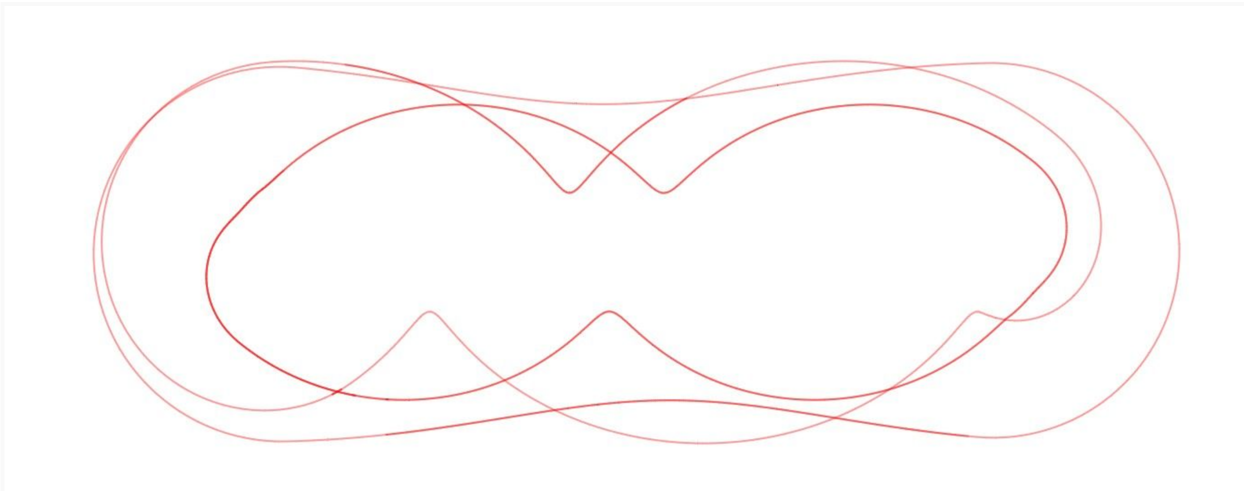
A line joining a planet and the Sun sweeps out equal areas during equal intervals of time.[1]



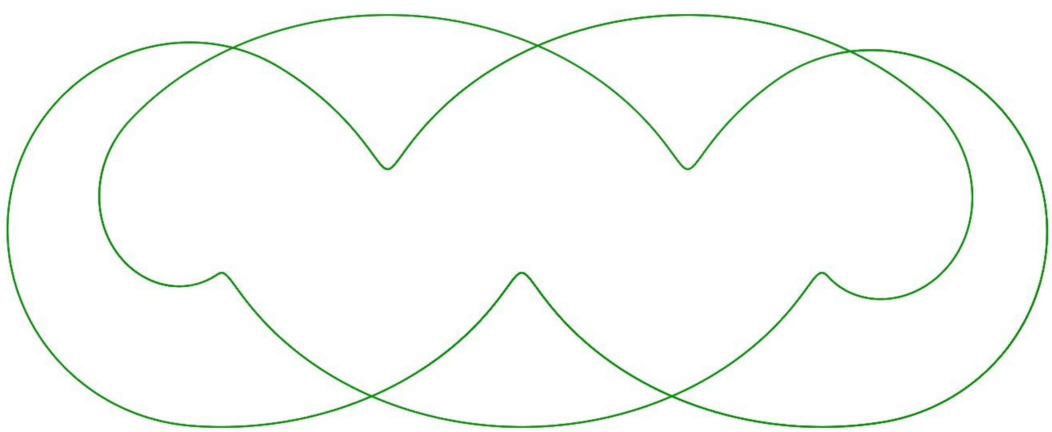
The same (blue) area is swept out in a fixed time period. The green arrow is velocity. The purple arrow directed towards the Sun is the acceleration. The other two purple arrows are acceleration components parallel and perpendicular to the velocity.

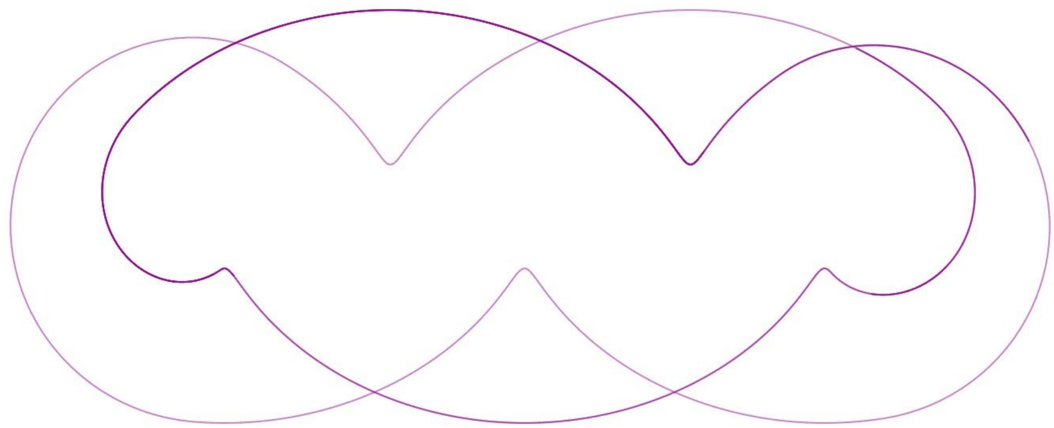
Earth moving faster when it is nearer to the Sun at perihelion and moving slower when it is farther away at aphelion.[1]

get your fix of smoke.
In his poem “The Golem”35 , Borges tells the story of the rabbi of Prague who, after long permutations, is able to find the key word that holds the secret of life. A monster, the Golem, is created, but the process involves more than magic words. Borges describes how the rabbi modeled his puppet and then trained him, like an ancient virtual pet, into the mysteries “of the Letters, Time and Space”. The golem learned very much like an expert system. But in this pessimistic view (similar to the myth of Frankenstein) this “simulacrum” –as Borges calls it– fails to reproduce the human soul. Certainly, simulation has its limitations, just like representation
In the differential geometry of curves, a **roulette** is a kind of curve, generalizing cycloids, epicycloids, hypocycloids, trochoids, and involutes.

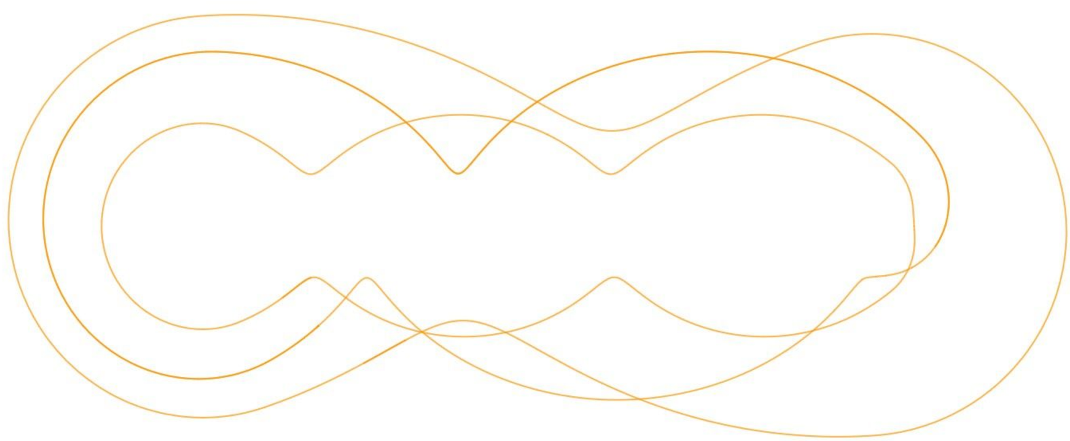


Spirograph - closed loops/curves when the size of <1> proportional to <2>
Keeping pencil at (any) same point on the <2> as it spirals around <1>

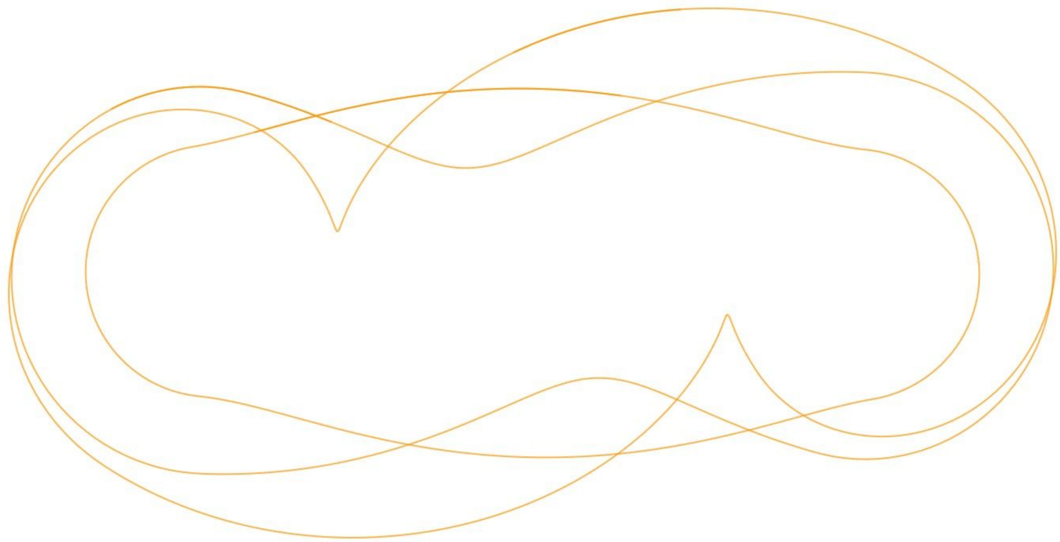




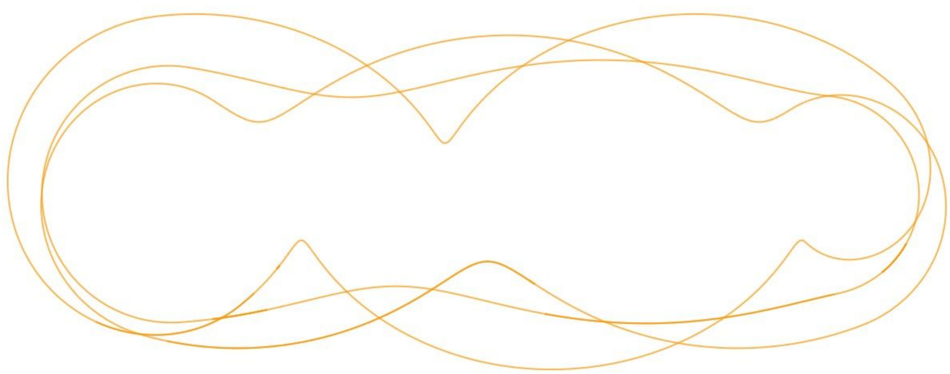
Closed loop after 2 cycles. Infinitely within these paths. <150> <60>



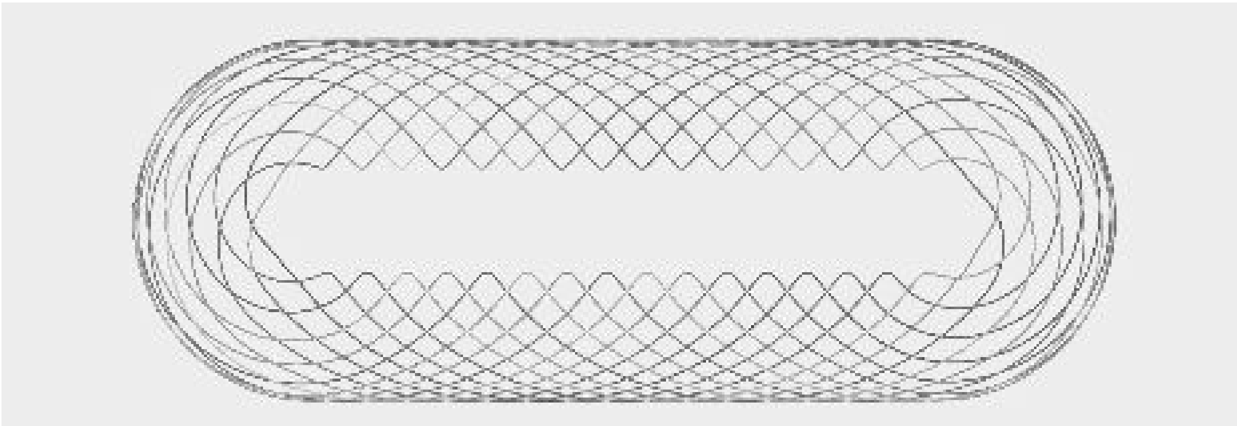
<150> to <30> <50> <75>



<150> to <75> at different points on the <75>



<150> to <50> at different points on the <50>



Let complete-

Lissajous Figure is a picture of **compound harmonic motion**
French physicist and mathematician Jules Antoine Lissajous (1822–1880)

The shape is drawn by plotting a two-variable parametric equation as it iterates itself over time — the resulting figure is the picture of two systems falling into and out of phase.
These two varying signals produce a perpetual infinity. Any figure may be transformed into any figure as the oscillating sine waves pass in and out of harmonic resonance.

Waves : particles